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(54) Abstract Title: **Applying DNA as an item label**

(57) In a method of labelling an item, a DNA sample of an individual is applied to an item, in order to be able to identify the individual as the owner of the property. Also disclosed is an apparatus featuring DNA specimen collection means, and a vessel containing a reagent to release the DNA. The DNA sample may be either applied directly to the item or may be incorporated into a composition, such as an ink, which is then applied. A protective film may then be applied over the DNA sample or composition. A fluorescent marker may be added to the DNA sample or composition to aid its subsequent location. To confirm the link, for example after loss or theft and subsequent recovery of the item, the DNA sample applied to the item is located and DNA recovered. The recovered DNA is then compared to DNA known to come from the individual, for example having been reserved during initial sampling. The individual him or herself may obtain the DNA sample and apply it as a label, for example using a kit provided containing the requisite reagents and equipment.

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METHOD AND APPARATUS FOR LABELLING PROPERTY

The present invention relates to a method for labelling property to facilitate its identification and recovery should it be lost or stolen. More particularly, but not exclusively, it relates to a method for labelling property with a means of identification that is unique to a particular individual owner. It further relates to equipment to perform such labelling.

Should items of property be lost or stolen, and then recovered, it may well be necessary to confirm their true ownership. It is also often important in the detection and punishment of theft and other crimes to prove that an item has been stolen and from whom. An important factor in the deterrence of crime is the likelihood of detection and conviction, and so items with an easily traceable provenance will usually be less attractive to a criminal. Thus, a simple and convenient identification method to allow items to be linked with their true owners would help to combat crime on several levels.

However it is important that such identification means should be hard for a criminal to defeat (or should be resistant to accidental defeat, in the case of mislaid items). Conventional address labels or the like are easily removed, obscured or obliterated, and may accidentally

become detached from an item. In any case, many valuable items would not be compatible with such labels.

It is known for identifying indicia to be engraved on an item, such as an owner's name, address, postcode or the like. However, not all items are suitable for such treatment, and such indicia may be difficult to alter, should the owner change address or pass on the item.

Concealed labelling has been employed, in which such identifying indicia are written on an item using an ink that is colourless under conventional illumination, but can be made visible, for example by exposing it to ultraviolet light. While this may be of assistance, a more sophisticated thief or receiver of stolen goods might be equipped with an ultraviolet lamp to check for such labelling, and could then wash the ink off or obliterate the indicia.

Any such labelling method using names, addresses or postcodes also has the further potential drawback that, if legible by a criminal, it may enable identity theft. Therefore, coded identification indicia may well be preferable, which can be linked back to a particular owner by authorised persons, but which do not provide useful information to others.

One proposed method entails preparing a suspension of microscopic particles, each of which bears the same coded information, unique to that particular suspension. The suspension is applied to an item, to which the particles adhere when it dries. The particles cannot be seen with the naked eye, but those in the know can retrieve a sample and examine them to read the code. There are several variants of this technology in which the code may comprise microdots readable under high magnification, mixtures of uncommon chemical elements, or even artificially-synthesised protein sequences that do not occur in nature. Any of these may

be "read" with the appropriate equipment to give an unique code that is looked up in a confidential database to see who purchased the corresponding solution.

An advantage of these methods is that a criminal can never be sure that every particle has been removed from an item, and identification may be possible from just one particle. On the other hand, the infrastructure required to produce all the uniquely-coded suspensions and to maintain the necessary secure records would be considerable. It may well be that the resulting cost of such methods would make them useful only for corporate customers or wealthy individuals, not for a majority of the general public.

It is hence an object of the present invention to provide a method of labelling items that obviates the above disadvantages, and provides an economical, convenient and reliable way of tracing an item back to its owner, either to aid its retrieval or to deter its theft. It is also an object of the present invention to provide apparatus to enable such a method to be carried out.

The term "item of property" as used herein may include a wide range of items from small items such as jewellery to large items such as motor vehicles, boats, aircrafts, caravans, and all items of intermediate size.

According to a first aspect of the present invention, there is provided a method of labelling an item of property to link it to a particular person, such as its owner, comprising the steps of collecting a specimen of cells from said particular person's body, obtaining a sample comprising deoxyribonucleic acid (DNA) from said specimen, and applying said sample or a composition containing said sample to said item of property.

Preferably, the method further comprises the steps of subsequently recovering DNA thus applied to the item of property and comparing it with DNA known to originate from said person.

Advantageously, said comparison step is carried out after loss or theft and subsequent recovery of the item of property.

Preferably, said collection, obtention and application steps are performed by said person him or herself.

Advantageously, the method then comprises the step of providing a kit comprising one or more reagents adapted to extract DNA from cells.

Said kit may also comprise equipment adapted to perform said collection and/or obtention steps.

Preferably, said obtention step comprises treating the specimen cells with a protease reagent.

Advantageously, the obtention step comprises dispersing the cells in a buffered medium, for example a lysis buffer, prior to treatment with the protease reagent.

The obtention step may be terminated by addition of a non-solvent for DNA, such as an alcohol, optionally ethanol or *iso*propanol.

The obtention step may be terminated by a chilling step.

Alternatively or additionally the obtention step may comprise treating the specimen cells with an ion-exchange resin, optionally an ion-exchange resin having a selective affinity for polyvalent metal cations.

The collection step may comprise collecting cells from an interior of the person's mouth, optionally from an interior of the person's cheek.

The collection step may be performed with a cytology brush or swab,

At least part of the sample comprising DNA may be retained for subsequent comparison steps.

Preferably, the method comprises the step of incorporating the DNA sample into a composition adapted for application to an item of property.

Advantageously, the composition comprises a surface coating composition, such as an ink composition, optionally a transparent ink.

The composition may comprise a volatile liquid that is a solvent for DNA.

Preferably, the method comprises the step of applying sealing or protective means over the DNA sample or the composition containing the DNA sample, once it has been applied to the item of property.

Advantageously, said protective means comprises a film-forming composition.

Alternatively, said protective means comprises a pre-formed film provided with adhesive means.

Preferably, the method comprises the step of adding marker means to the DNA sample so as to aid location thereof once applied to the item of property.

Said marker means may comprise a material that fluoresces under ultraviolet illumination.

Preferably, the method comprises the step of applying to the item of property label means adapted to indicate that the item has been labelled with DNA.

Optionally, said label means may be applied protectively over the applied DNA sample.

The method advantageously comprises the step of displaying notice means, for example so displayed as to be visible from outside a dwelling, to indicate that one or more items of property therein have been labelled with DNA.

According to a second aspect of the present invention, there is provided apparatus to enable labelling of an item of property with DNA to link it to a particular person, comprising means to collect a specimen of cells from the person and first vessel means containing a pre-selected quantity of a reagent adapted to react with body cells to release DNA therefrom.

Preferably, said reagent comprises a protease reagent, such as Protease K.

Advantageously, the apparatus comprises second vessel means containing a pre-selected quantity of a medium adapted for said cells and said reagent to react together therein.

Said medium may comprise a lysis buffer.

Alternatively, the apparatus comprises second vessel means containing a preselected quantity of an ion-exchange resin, optionally an ion-exchange resin having a selective affinity for polyvalent metal cations.

The apparatus may comprise third vessel means containing a material adapted to terminate reaction between the reagent and the cells, such as ethanol or *iso*propanol.

Preferably, the apparatus comprises a composition adapted to be applied to an item of property and into which a sample comprising DNA obtained from said cells may be incorporated.

Said composition may comprise a coating composition, such as an ink composition.

Preferably, the apparatus comprises sealing or protective means adapted to protect a DNA sample that has been applied to the item of property.

Advantageously, said sealing means comprises a film-forming composition.

Alternatively, said protective means comprises a pre-formed film provided with adhesive means.

Preferably, the apparatus comprises marker means adapted to aid location of the DNA sample once it has been applied to the item of property.

Said marker means may comprise a material that fluoresces under ultraviolet illumination.

Preferably, the apparatus comprises label means adapted to be applied to an item of property to indicate that it has been labelled with DNA.

The apparatus may additionally or alternatively comprise notice means adapted to be displayed to indicate that one or more items of property on the vicinity of the notice means are labelled with DNA.

Said notice means may be adapted to be displayed on doors or windows of a dwelling.

Preferably, the apparatus is provided as a kit, further comprising instruction means adapted to indicate to a user how he or she may obtain a sample comprising his or her DNA and employ it to label an item of property.

Embodiments of the present invention will now be more particularly described by way of example.

A first kit embodying the present invention, adapted to allow a user to prepare a sample of his or her own DNA, comprises three capped sample tubes, individually identifiable (for example by colour markings or coloured caps) and containing DNA extraction reagents, and at least one standard cytology brush (commonly referred to as "a swab"). A sterile pipette

and a holder, stand or rack for the sample tubes are also provided, for convenience. Optionally, a clock or timer and a thermometer are also provided, though the user may provide his or her own. Normally, the user would also employ his or her own kitchen vessels to hold ice baths and the like, although suitable vessels may be provided with the kit if desired.

A first of the sample tubes contains a preselected quantity of a conventional lysis buffer, a second of the tubes contains a preselected quantity of a conventional protease reagent, and a third of the tubes contains a preselected quantity of an alcohol, such as ethanol. The exact quantities and proportions used depend on the particular (off-the-shelf) reagent combination selected.

One particularly effective lysis buffer comprises 50mM (millimolar) Tris (*tris*-hydroxymethylaminomethane) and 15mM SDS (sodium dodecyl sulphate, also known as sodium lauryl sulphate, an anionic surfactant which also acts to open out protein structures, assisting subsequent enzyme or chemical attack). This combination has a pH of around 8.0. The preferred protease reagent is Protease K (also known as proteinase K or peptidase K, an endolytic protease that may be isolated from the fungus *Tritirachium album*, and which has high activity over a wide range of conditions). The alcohol is preferably 95% ethanol; alternatively, 91% *iso*propanol may be used.

The user prepares his or her DNA sample as follows. The third tube containing ethanol or other alcohol is chilled in a freezer or on ice for at least twenty minutes, while the first and second sample tubes are set up in a tube holder. A first small bowl is partially filled with a mixture of ice and water to create an ice bath, while a second small bowl or cup is filled with

hot water from the tap. This hot water bath should be at just above 55°C at the start of the preparation. Its temperature should be monitored with the thermometer throughout and maintained within the range 50°C to 55°C, for example by topping up with more hot water when necessary.

The user takes a first cytology brush and rubs it inside one cheek for at least one minute to collect a sample of cells (a "buccal swab"). The cytology brush is then plunged into the lysis buffer in the first sample tube and agitated vigorously to ensure that the sampled cells are thoroughly dispersed in the lysis buffer. Preferably, a second cytology brush is used to collect another sample of cells from within the user's other cheek, which is dispersed in the same lysis buffer, as described above. The first sample tube is then capped, and swirled and rocked manually to ensure complete mixing of the cells into the lysis buffer.

The lysis buffer is then transferred into the second sample tube containing the protease reagent. The second sample tube is securely capped and rocked to and fro, ideally at least ten times, to ensure mixing of the lysis buffer and the protease reagent and full access for the protease to the sampled cells.

The second sample tube is then replaced in the holder and put into the hot water bath. The tube is kept in the hot water bath, held at 50°C - 55°C, for at least twelve minutes, to enable the protease to react fully with the cells.

After this period, the second sample tube, still in the holder, is removed from the hot water bath and placed in the ice bath. The sterile pipette is used to drip the chilled ethanol, etc, from the third sample tube slowly into the second sample tube, preferably running the drops

of ethanol down the inside walls of the second sample tube into the mixture of lysis buffer, protease reagent and digested cells. Once all the ethanol or other alcohol has been added, the second sample tube is capped again and rocked gently. A whitish gelatinous precipitate of DNA then begins to fall out of the solution. To encourage further precipitation, the sample tube may be left in the ice bath or even transferred to a domestic freezer. While sufficient DNA for most purposes will be produced in ten or fifteen minutes, the sample may be left overnight or longer in the freezer if preferred.

Once a DNA sample has been isolated, it is believed to be stable indefinitely in a freezer. Even stored in a domestic refridgerator or at room temperature, the DNA sample will remain usable for much longer than would be required for the purposes of the present invention.

A second kit embodying the present invention replaces the lysis buffer with a suspension of ion-exchange resin, though a protease reagent is again employed. The preferred ion-exchange resin is one which selectively chelates polyvalent metal cations, for example a styrene-divinylbenzene copolymer having iminodiacetate active groups. The resin is preferably provided as fine beads and prepared as an aqueous suspension. A particularly suitable product is Chelex 100 resin, sold by Bio-Rad Laboratories, Inc, especially the molecular biology grade in the form of 100-200 mesh particles, and used as 5% by weight suspension in water. Protease K is again the protease reagent of choice.

As with the first kit, the user takes a buccal swab of cells by rubbing a cytology brush inside one cheek for at least one minute. The cytology brush is then plunged into the Chelex 100 suspension, contained in a first sample tube, and agitated vigorously to transfer and disperse

the cells. A second buccal swab may be taken and added to the Chelex 100 suspension if desired.

The suspension of Chelex 100 and buccal cells is then mixed with an aqueous solution containing 10μg/ml Protease K, in a second sample tube, and shaken to mix thoroughly. The second sample tube is then incubated at 60°C (e.g in a hot water bath) for twenty to forty minutes, shaking at least once during the incubation. Finally, the contents of the tube are boiled for ten minutes to complete the reaction, destroy the protease and precipitate out the DNA extracted from the cells.

The DNA precipitate is collected and may be stored (if required) as described above in respect of the first kit.

The isolated DNA sample may then be used to mark items of property. For example, a tiny amount of DNA may be applied directly to an item using a pin or the like. Alternatively, a portion of the sample may be redissolved or dispersed in water or another liquid, and the resulting solution/dispersion dabbed on to the item so that it leaves a smear of DNA when it dries. In a preferred embodiment, the kit also comprises an ink or ingredients to make an ink, into which a portion of the DNA sample is incorporated. The resulting ink is then applied to the item. In each case, the DNA is preferably applied to the item where it would be difficult for it to be accidentally or deliberately removed, such as at a seam in a casing or in recesses in an item of jewellery.

Should a labelled item be lost or stolen, then recovered, forensic examination will show the presence of the DNA label. It is straightforward with current DNA handling techniques to

produce a DNA "fingerprint" from traces of DNA much smaller than would be produced by the above approach. To confirm his ownership of the item, the owner could supply a portion of his retained DNA sample, or a fresh sample, for comparison purposes. Alternatively, he could have a DNA fingerprint produced from his sample in advance, which he would store securely and produce for comparison purposes when necessary.

It is not necessary in any of these cases for a central database of DNA fingerprints to be kept. This removes a major component of the cost of many of the existing labelling methods. It also accords with many people's reluctance to have their DNA or other very personal information kept on a database or other filing system outside their control. Essentially, the owner acts as his or her own database record.

Another highly significant advantage of the approach of the present invention over existing methods is that the whole DNA preparation and labelling procedure is carried out by the user himself or herself. There is no need to have labelling material prepared in advance by specialists, as is the case for the coded microparticle labelling methods, for example. The reagents and equipment required to make up the kit described are all relatively cheap nowadays. Thus, the approach of the present invention is far more economical then existing methods, bringing it within the reach of typical members of the general public.

Further developments of the kit and methods described above are envisaged. In one, the kit also comprises a fluorescent marker liquid, to be mixed with the DNA or the ink, as appropriate. This allows someone checking a recovered item to locate the DNA label more easily. Even if this allowed a criminal to spot the label, he would have great difficulty in removing all traces of DNA from the item. Fluorescers having an excitation maximum at a

wavelength of around 365 nm are believed to be particularly suitable, since ultraviolet light sources of around this wavelength are widely available.

Another development proposed is to provide in the kit a sealant or protective coating material to be applied over the DNA label to protect it from inadvertent or deliberate removal. While the removal of all of an unprotected DNA label would be very difficult, the more DNA that is present, the easier its identification will be. This would also help to prevent the DNA label swamping DNA traces left subsequently by a criminal, which might be important as evidence. This protective coating could also be made fluorescent so that a forensic scientist may locate it more readily and, for example, scrape through it to sample the DNA label below (transparent adhesive labels might also be used for this purpose).

Because much of the benefit of property labelling comes from its deterrent effect, the kit normally also comprises a plurality of conventional warning labels. These comprise labels to be displayed on premises to indicate that valuables therein are DNA labelled, and labels to be applied to a particular item to indicate that it is also DNA labelled (jewellery and the like might not be compatible with such item labels, but cameras, computers, televisions and even mobile phone handsets would be suitable, for example). The item labels could also be used to cover the area of the DNA label, if desired.

Such premises and item labels would indicate to a potential thief that valuables (which might otherwise be easy to dispose of once stolen) could easily be traced back to the owner from whom they were stolen. Since this would increase the thief's chances of being detected and convicted, he would be discouraged from stealing that item or from those premises.

A further embodiment of the invention comprises a plurality of kits, preferably of the first kits, supplied together with instructions and a lesson plan, for use by schoolchildren as part of science classes. This would instruct children in essential biochemistry, give them a concrete example of applied science, and provide them a useful labelling system to apply to their personal property into the bargain

For students learning about the molecular framework of biology for the first time, DNA is abstract and intangible. This procedure makes the invisible visible – seeing their own DNA makes it real to them – and has a real life practical end use when used to mark their own and family property.

This activity should be possible in any standard classroom environment, and requires no specialised and expensive equipment.

There are three different lesson plans in development for different age groups (basic, advanced and extension activities) and each has the ability to integrate a multiple core curriculum subject matter which is informative and cross-cutting (i.e. it takes a biological science together with a societal problem and seeks an acceptable solution within a democratic and law-abiding society).

CLAIMS

1. A method of labelling an item of property to link it to a particular person, such as its owner, comprising the steps of collecting a specimen of cells from said particular person's body, obtaining a sample comprising deoxyribonucleic acid (DNA) from said specimen, and applying said sample or a composition containing said sample to said item of property.

2. A method of labelling property as claimed in claim 1, further comprising the steps of subsequently recovering DNA so applied to the item of property and comparing it with DNA known to originate from said person.

3. A method of labelling property as claimed in any one of the preceding claims, wherein said collection, obtention and application steps are performed by said person him or herself.

4. A method of labelling property as claimed in any of the preceding claims, comprising the step of providing a kit comprising one or more reagents adapted to extract DNA from cells and optionally further comprising equipment adapted to perform said collection and/or obtention steps.

5. A method of labelling property as claimed in any one of the preceding claims, wherein said obtention step comprises treating the specimen cells with a protease reagent.

6. A method of labelling property as claimed in any one of the preceding claims, wherein at least part of the DNA sample is retained for subsequent comparison steps.

7. A method of labelling property as claimed in any one of the preceding claims, comprising the step of incorporating the DNA sample into a surface coating composition adapted for application to an item of property, such as an ink composition, optionally a transparent ink.

8. A method of labelling property as claimed in any one of the preceding claims, comprising the step of applying sealing or protective means, optionally a film-forming composition or a pre-formed film provided with adhesive means, over the DNA sample or the composition containing the DNA sample, once it has been applied to the item of property.

9. A method of labelling property as claimed in any one of the preceding claims, comprising the step of adding marker means, such as a material that fluoresces under ultraviolet illumination, to the DNA sample or to the composition, to aid location thereof once applied to the item of property.

10. A method of labelling an item of property with DNA substantially as described herein.

11. Apparatus to enable labelling of an item of property with DNA so as to link it to a particular person, comprising means to collect a specimen of cells from said person

and first vessel means containing a pre-selected quantity of a reagent adapted to react with body cells to release DNA therefrom.

12. Apparatus as claimed in claim 11, wherein said reagent comprises a protease reagent, such as Protease K.

13. Apparatus as claimed in either claim 11 or claim 12, comprising second vessel means containing a pre-selected quantity of a medium, for example a lysis buffer, adapted for said cells and said reagent to react together therein.

14. Apparatus as claimed in either claim 11 or claim 12, comprising second vessel means containing a preselected quantity of an ion-exchange resin, optionally an ion-exchange resin having a selective affinity for polyvalent metal cations.

15. Apparatus as claimed in any one of claims 11 to 14, comprising third vessel means containing a material adapted to terminate reaction between the reagent and the cells, such as ethanol or *iso*propanol.

16. Apparatus as claimed in any one of claims 11 to 15, comprising a composition adapted to be applied to an item of property and into which a sample comprising DNA extracted from said cells may be incorporated, optionally comprising a coating composition, such as an ink composition.

17. Apparatus as claimed in any one of claims 11 to 16, comprising sealing or protective means adapted to protect DNA that has been applied to the item of property.

18. Apparatus as claimed in claim 17, wherein said sealing means comprises a film-forming composition.

19. Apparatus as claimed in claim 17, wherein said protective means comprises a pre-formed film provided with adhesive means.

20. Apparatus as claimed in any one of claims 11 to 19, comprising marker means adapted to aid location of the DNA sample once it has been applied to the item of property.

21. Apparatus as claimed in claim 20, wherein said marker means comprises a material that fluoresces under ultraviolet illumination.

22. Apparatus as claimed in any one of claims 11 to 21, provided as a kit and further comprising instruction means adapted to indicate to a user how he or she may obtain a sample comprising his or her DNA and employ it to label an item of property.

23. Apparatus for labelling an item of property with DNA, substantially as described herein.

Application No:	GB0701221.4	**Examiner:**	Mr Michael Young
Claims searched:	1-10	**Date of search:**	27 February 2007

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-4 at least	EP 1394544 A1 (BLOWELL) Whole document relevant.
X	1-4 at least	WO 02/086052 A3 (AMESBURY) Whole document relevant.
X	1-4 at least	WO 03/080931 A1 (TRACE TAG..) Whole document relevant.
X	1-4 at least	US 2005/0008762 A1 (SHEU ET AL..) Whole document relevant.
X	1-4 at least	US 5139812 A (LEBACQ) Whole document relevant.
X	1-4 at least	WO 98/06084 A1 (BEIJIN SANZHU) See translated abstract on front cover.
X	1-4 at least	FR 2775693 A1 (GENOLIFE) See provided translated abstract.
X	1-4 at least	JP 2005053091 A (OIKE) See provided translated abstract.
X	1-4 at least	JP 2005293531 A (GOUNAI) See provided translated abstract.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

B8F

Worldwide search of patent documents classified in the following areas of the IPC

B65C; G09F

The following online and other databases have been used in the preparation of this search report

WPI EPODOC